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Review Articles

Structuring of the periodization in antiquity: the Roman military training

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A. Conception and design of the study; B. Acquisition of data; C. Analysis and interpretation of data; D. Manuscript preparation; E. Obtaining funding

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Abstract

Background and Study Aim. The sportive periodization originated from the military periodization of ancient civilizations and of the Greek Tetrad for the sportive preparation the ancient Greek athletes. The objective of the review was to explain the periodization of the Roman military training.

Materials and Methods. The articles were selected in January and February of 2024 in 10 databases (Google Scholar, PubMed, Research Gate, Scielo, Redalyc, Scopus, DOAJ, ScienceDirect, Semantic Scholar, and Latindex) with the following keywords: Roman military training, Roman soldiers, Roman Empire territory, Tetrad during Roman military training, Roman military equipment, and Roman military tactics.

Results. Ancient Rome conquered almost all Western Europe, North Africa, and part of the Middle East because the nation was very militarized. The military training during ancient Rome for the soldiers and sailors had several types of training that were physical training, training, technical training, and technical and tactical training. So, for the war coach to organize all these training sessions for the Roman military, he needed to structure the periodization. The periodization of the Roman military training was used with several mesocycles of 4 to 6 months of duration during various moments of the year for the soldier and the sailor to always be prepared for war. In 146 B.C., the Roman Empire conquered ancient Greece and after this moment, the Romans used the scientific knowledge of the Greeks to structure the Roman military training. Then, the Romans used the Tetrad of the Greeks to structure the military training. Roman military training was structured with several Tetrad during 4 to 6 months. Therefore, the Tetrad was inserted into the mesocycle of 4 to 6 months.

Conclusions. In conclusion, the periodization of the Roman military training was very organized for the military to achieve a high performance in the war.

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Introduction

Periodization began with the ancient military training of the Chinese (Marques Junior, 2023a), Egyptians, Greeks, and Romans (Barbanti, 1997; Marques Junior, 2022a). However, during this period, the term periodization did not exist. The term periodization originated from the word period (Bompa, 2002). The periods were created after of the Russian Revolution of 1917 by Russian sports scientists (Marques Junior, 2023b). So, the term periodization may be a Russian creation.

Other terms were created by the Russian Lev Pavilovch Matveev during the Soviet Union, they were the macrocycle, the mesocycle in 1971, and the microcycle in 1962 (Marques Junior, 2023c). The macrocycle is all contents of the sportive periodization, the mesocycle is composed of some microcycles and has a few weeks or months, and the microcycle consists of 2 days or more of training (Matveev, 1991; Moura et al., 2023; Platonov, 2004). The microcycle has a training load and is practiced in the session according to its training characteristics (Costa, 2022; Marques Junior, 2021a). For example, the shock microcycle the training is strong, the recuperative microcycle the training is with low load, and others (Marques Junior, 2023d; Platonov, 2004). Therefore, all these terms were created in the sportive periodization.

But the article is about the Roman military training. The study about the periodization of the Romans is important to understand how sports scientists based this content created the sportive periodization (Marques Junior, 2012). The 1st sportive periodization was created by the ancient Greeks, the microcycle was formed by Tetrad (Montero, 2020). After this period, the sports scientists of Soviet Russia and the Soviet Union improved the periodization (Issurin, 2014; Stone et al., 2021). Therefore, the article used the terms of the sportive periodization to explain how it was structured the periodization of the Roman military training.

The ancient Rome had a period of 753 before Christ (B.C.) until 476 during Christ (D.C.), the main physical activity of this nation was the military training (Fernández, 2018; Fernández, 2023; Ponte, 2017). Ancient Rome had three moments, the Roman Monarchy (753 to 509 B.C.), Roman Republic (509 to 27 B.C.), and Roman Empire (27 B.C. to 476 D.C.) (Fernández, 2018; Henrique, 2020; Ponte, 2017). Military training in ancient Rome began with children and continued into adulthood (Marques Junior, 2022b). The tasks for military preparation were swimming, use of weapons (archery, spear, sword), horse riding, canoeing, athletics, and other exercises. The militarization was so great that the entertainment was the gladiator fights (Marques Junior, 2021b).

This attention with the military training provided to the ancient Rome conquered almost all Western Europe, North Africa, and part of the Middle East. An of the reasons for these Roman conquests is related to the elaboration of war books for the study of the combat – technique of using weapons and war tactics (Tavares & Gonçalves, 2023). These war books were presented for the Roman military the periodization to organize the military training.

How the periodization of the Roman military training was structured?

Sports training articles (Api & Arruda, 2022; Cortes, 2023; Virgen et al., 2023), and books (Gomes, 1999; Padilla, 2017; Zakharov, 1992), do not have this information. Then, this content is important because the sports training literature did not inform how the periodization ot the Roman military training was structured. Therefore, this article is rare in the sports training literature because the physical education teacher will learn how the mesocycles and microcycles were structured during the Roman military training. The objective of the review was to explain the periodization of the Roman military training.

Materials and Methods

Search Strategy.

The articles were selected in January and February of 2024 in 10 databases (Google Scholar, PubMed, Research Gate, Scielo, Redalyc, Scopus, DOAJ, ScienceDirect, Semantic Scholar, and Latindex) with the following keywords: (“roman military training” AND “roman soldiers” AND

"roman empire territory" AND "tetrad during roman military training" AND "roman military equipment" AND "roman military tactics").

Exclusion Criteria.

The author of the study practiced analytical research of the type historical and of review to explain how the periodization of the Roman military training was structured (Thomas & Nelson, 2002). The included articles were selected using the following research strategies: (1) ancient Rome, (2) the type of task that was during the Roman military training, and (3) data collected on the structure of the Roman military training. Articles that did not meet these three criteria were excluded.

Procedur.

After collecting the articles, the author wrote the results about the periodization of Roman military training. Most of the articles were discarded because they did not mention the periodization of Roman military training. All articles were extracted from their sources and analyzed through Mendeley software to eliminate duplication of articles.

Results

Ancient Rome had several territories conquered because the nation was very militarized – see the territory in figure 1 (Coulston, 2004; Davies, 2024; Ramalho et al., 2021). Military training began at 7 years of age (Souza, 1972), and the period of military service began at 16 years of age (Parpiev, 2023). The minimum stature for military service was 1.70 meters (m), but a Roman very strong with the stature of 1.60 to 1.65 m the person could enlist in military service (Ponte, 2017).

Figure 1. Roman Empire with territory in the pink of the regions of Western Europe, North Africa, and part of the Middle East (27 B.C. to 476 D.C.) (Extracted in https://www.rome.net/roman-empire).

The age of the Romans in military service was between 16 to 28 years old (Marques Junior, 2022b). The time of the military service was of 6 years, but during a long war, the Roman military had 20 of service (Lei, 2023). The duration of service of the cavalry was at most 10 years, and the service time of the infantry was at most 16 years (Lie, 2023). The majority of the military completed the military service at the age of 25 years old (Ponte, 2017). Therefore, the life of a Roman military was very hard, during the training and at the time of war. Figure 2 presents the infantry and cavalry of the Roman Empire.

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Figure 2. Type of military of the Roman Empire: infantry soldier (Extracted of Westphalen, 2020) and cavalry soldier (Extracted of https://abutterfly.beauty/ancient-roman-cavalry).

The military training during ancient Rome for the soldiers and sailors had several types of training that were physical training with strength training and cardiopulmonary training, technical training with the use of weapons, tactical training with the study of combat through of books and military classes, the technical and tactical training which was the team training that simulates a combat, and the martial art training (Marques Junior, 2022b; Westphalen, 2020).

The Roman military had to train constantly to maintain good physical fitness and was technically and tactically well-prepared for the war (Argüín, 2011; Parpiev, 2023). Then, Roman military training used the principle of the continuity of sportive training (Matveev, 1995). But it did not exist in ancient Rome the principle of continuity. The person responsible by military training knew that the continuity of the training was important for the soldier and the sailor to be prepared for war or the military to be prepared for a possible enemy attack (Fernández, 2018). Generally, the person responsible by military training was a war veteran because he had a high practical and theoretical knowledge to teach the soldiers and sailors (Soria, 2018).

Physical training was very important for the Roman military because, during a war, the soldier and the sailor had a high resistance to the effort of long combat (Gonçalves, 2016). Military strength training was practiced with the heaviest wooden weapons (sword, spear, shield, and others) to develop strength with the weapons and improve the technique (Fernández, 2018; Kraemer & Häkkinen, 2004). This activity was the special strength preparation, this training was scientifically developed by Russian Yuri Vitali Verkhoshanski of the former Soviet Union (Verkhoshanski, 2001). However, this term did not exist in ancient Rome, and there was no scientific study on this training.

The complementary strength training for the military of ancient Rome was useful in the cooperation and coordination, this task the soldiers and sailors performed in building the fortifications for the combat (Coulston, 2013).

Another type of physical training for the Roman military (soldier and sailor) was the cardiopulmonary training (Porter, 2023). Roman military practiced during the cardiopulmonary training the endurance march of 8 to 32 kilometers (Gómez, 2010), with slow to medium velocity (Fernández, 2018). Generally, the endurance march was practiced by soldiers carrying weapons, armor, helmet, and other war equipment that had approximately 35 kilos (Rojo, 2019). The endurance march was practiced in the forest, climbing mountains, passing through rivers, and in other places (Gonçalves, 2016). The cardiopulmonary training was practiced with other exercises for the soldier and sailor – swimming, continuous running, a primitive game of football, the old interval training with running until a short distance, and after the military practiced a pause, this action of effort and

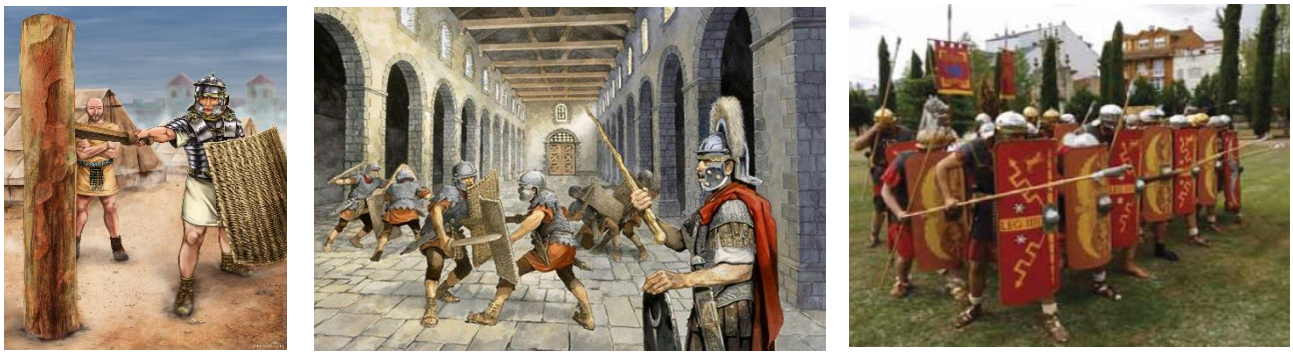
pause was by some minutes, the old fartlek with running, jump, march, pause, and others actions (Cadena, 2023; Gómez, 2010; Porter, 2023; Tubino & Moreira, 2003).

The physical training with the strength training and/or with the cardiopulmonary training required more effort from Roman military and was practiced in the hot, cold, and with strong rain (McAvoy, 2017). This training in adverse weather was also practiced during the technical training with the use of weapons and in the technical and tactical training with the team training that simulates a combat.

Technical training the Roman military trained with various types of weapons and/or used wooden weapons with exercises practiced in the air and/or attacking a post fixed in the ground (the *palus*) with the objective of improving weapon combat technique (Fernández, 2018; Gómez, 2021). During the technical training, the Roman military could practice integrated training because it occurred at the same time as the technical training and the strength training when the military practiced the training with the heaviest wooden weapons (Zakharov, 1992). This term, integrated training, did not exist in ancient Rome.

During the technical training and in the integrated training (technical training with the strength training) the Roman military practiced more the exercises with the weapons that he was an expert (Gómez, 2021). This type of training was related with the principle of specialization (Gomes, 1999). This content of the sportive training did not exist in ancient Rome, but the war coach knew that specializing in a weapon resulted in better military performance in the war. This specialization with a type of weapon occurred in the technical and tactical training, during the team training each Roman military used the weapon most frequently that was specialized.

Technical and tactical training the Roman military practiced team training with collective actions of attack and defense (Gómez, 2010, 2021). This action was very trained for soldiers and sailors have coordination during real combat (Marques Junior, 2023a). Technical and tactical training exercises were with actions of attack and defense in the air and could occur with integrated training, the military practiced this training with the heaviest wooden weapons. The other technical and tactical training was the team training that simulates combat (Westphalen, 2020). Then, the training that simulates combat occurred with the wooden weapons to have fewer injuries (Fernández, 2018; Marques Junior, 2021b). This training was practiced with a fight between the soldiers and/or sailors. During the combat training, the military could be without weapons and he had to fight with the Roman martial arts, wrestling (McAvoy, 2017). The wrestling training was developed during the martial arts training, the two soldiers and/or two sailors practiced wrestling fighting. Figure 3 presents some types of training practiced by the Roman military.



A **B** **C**

Figure 3. (A) Technical training with sword attack on the *palus*, (B) technical and tactical training between soldiers with fight of wooden sword and shield (Extracted of https://inaciem.com/diary/exercitacio), and (C) technical and tactical training with team training in the traditional attacking position (Extracted of Rojo, 2019).

So, for the war coach to organize all these training sessions (physical training, technical training, technical and tactical training, and martial arts training) for the Roman military, he needed to structure

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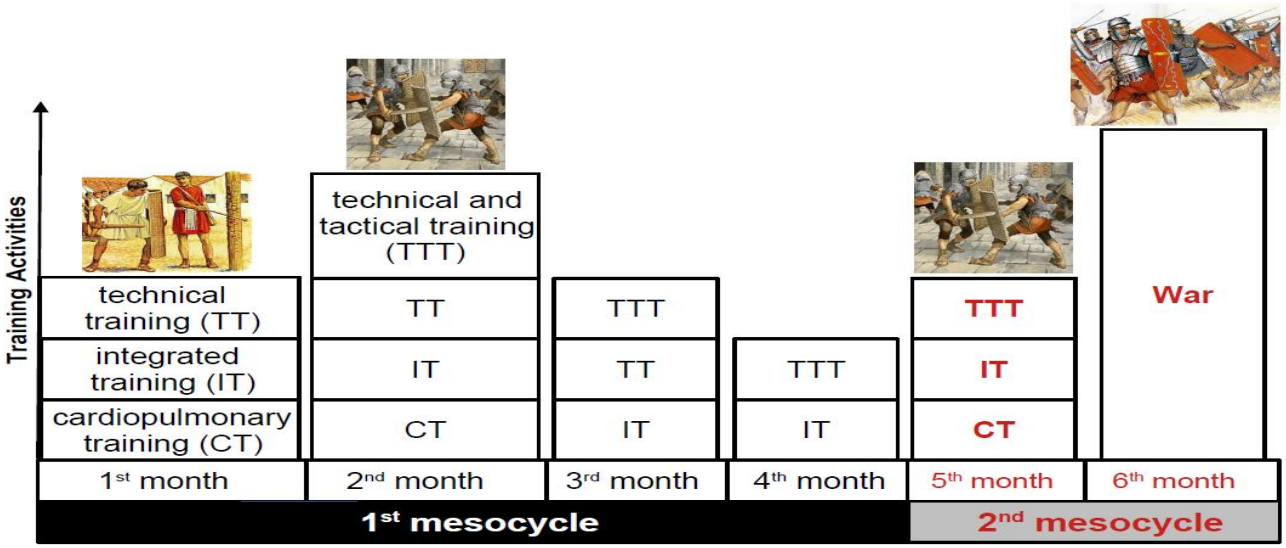
the training planning (Stout, 1921). But in this article, the author used the term periodization of the sportive training to explain how the training planning was organized. Other terms used of the sportive training were the mesocycle, and the microcycle to explain the military periodization of the Romans. Remember, all these terms were not used in ancient Rome.

The ancient periodization of the Roman military training was used with several mesocycles of 4 to 6 months of duration during various moments of the year for the soldier and the sailor to always be prepared for war (Fernández, 2018; Sorrosal, 2013). Then, the Romans organized the military training with a period of duration (4 to 6 months) that caused an improvement in the physical preparation, technique, and tactics of the military.

After of 4 to 6 months of the mesocycle, the war coach prescribed some tests to check the military`s progress with the trainer (McAvoy, 2017; Stout, 1921). Then, the war coach evaluated the physical preparation with the long march of the military and determined the technical and tactical quality during the combat training with wooden weapons, practicing wrestling combat training, and in the team combat training with wooden weapons. Therefore, the Roman military training was very updated for the moment. The training was similar to athlete preparation (Costa, 2022; Matveev, 1991).

Figure 4 presents an example of how the mesocycle could be structured. The reader can observe that the training load of each mesocycle is related to the quantity of activities. However it was not found in the Roman military training literature another way to measure training load. In the example of figure 4, the Roman military practiced 5 months of training and in the 6th month a war occurred with an enemy of ancient Rome. Remember, at the end of each mesocycle the war coach prescribed some tests to evaluate the military, but in the example of figure 4 the test was the war.



IT activity (strength training + technical training**):** heaviest wooden weapons.

TTT activity: team training with actions of the weapons in the air, combat training with wooden weapons and/or wrestling.

Figure 4. Mesocycle of the Roman military training with 6 months of duration (Elaborate by the author).

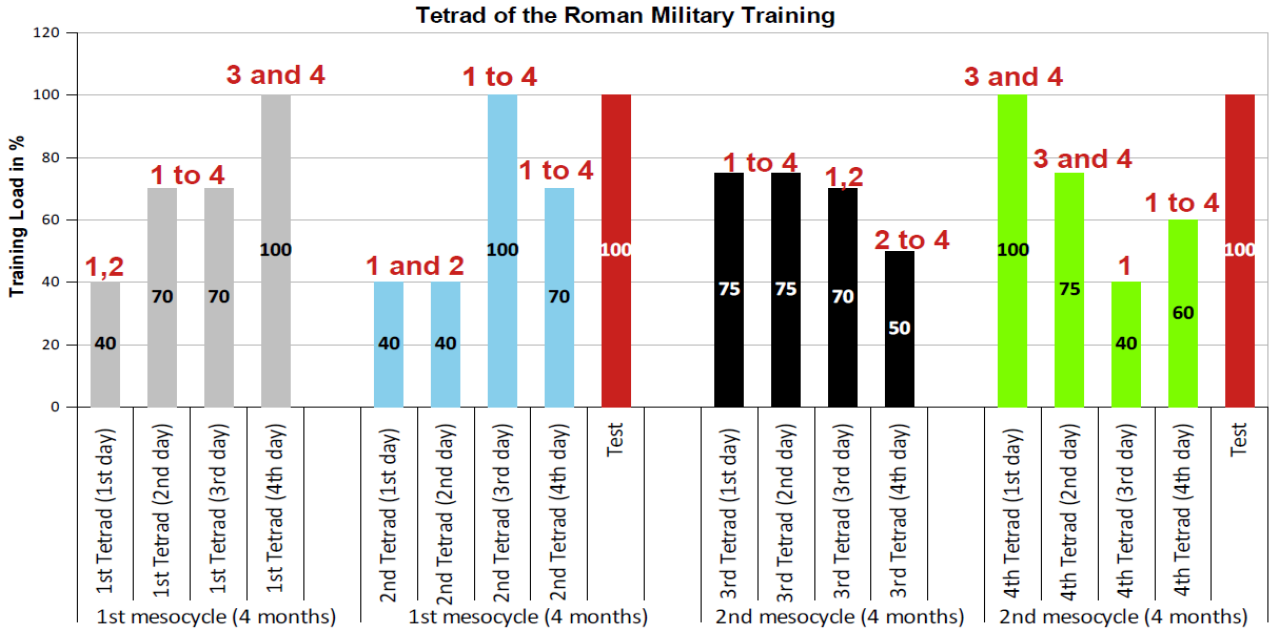
Ancient Rome had several wars with various civilizations when was Roman Monarchy (753 to 509 B.C.), Roman Republic (509 to 27 B.C.), and Roman Empire (27 B.C. to 476 D.C.) (Henrique, 2020; Ponte, 2017). In 146 B.C., the Roman Empire conquered ancient Greece and after this moment, the Romans used the scientific knowledge of the Greeks to structure the Roman military training (Marques Junior, 2021b; McAvoy, 2017). Then, the Romans used the Tetrad of the Greeks to structure the military training. The Tetrad was the microcycle of the Greek athletes for preparation in the ancient Olympic Games (Montero, 2020; Padilla, 2017). The Tetrad was organized with four days of training, the Greek coach prescribed different training loads each day for the athlete perform the

training tasks of the sport in which he competes (Costa, 2022). The Tetrad was performed with the following training load: 1st day had light training, 2nd day was with hard training, 3rd day the athlete practiced a passive or active rest, and 4th day the training load was medium (Marques Junior, 2022b).

The Tetrad was criticized by Roman war coaches because the training was structured with a rigid training load, in four days of training the military practiced the same load training (Porter, 2023; Stocking, 2016). Then, the Roman war coach practiced adaptations of the Tetrad for the soldiers and sailors have better training. The Tetrad applied in the Roman military training had a load training of four days different from the Greek Tetrad, the Roman war coach determined the load training (light, medium, hard, and passive or active rest) according to the objective of the microcycle, which was the Tetrad (Porter, 2023). The Tetrad had four days with the training load of several variations, for example, four days of hard load, or two days of light load and two days of hard load, and other variations of the training load.

The Roman war coach knew that 4 to 6 months of military training caused improvement in the Roman military (physical preparation, technique, and tactics) (Fernández, 2018; Sorrosal, 2013). Then, the Roman military training was structured with several Tetrad during 4 to 6 months, after this period the military practiced tests for the war coach to determine the effect of the training (Porter, 2023). Therefore, the Tetrad was inserted into the mesocycle of 4 to 6 months. This procedure occurs in Matveev`s traditional periodization, the microcycle inserted in the mesocycle (Matveev, 1991).

Figure 5 presents an example of the Tetrad in the mesocycle with the types of training. The author did not find how the Roman war coach determined a training load light, medium, hard, and very light in the active rest for the military training. Then, the training load of each day of the Tetrad was presented by percentage to facilitate the explanation of figure 5. However, in ancient Rome, the percentage was known. In figure 5, a light load was 10 to 40%, a medium load was 50 to 70%, a hard load was 75 to 100% (Marques Junior, 2023d), and a very light load in the active rest was 5 to 9%. The 1st and 2nd Tetrad were used several moments in the 1st mesocycle that had a duration of 4 months. After this mesocycle, the war coach prescribed the tests to determine the effect of the training in the military. The other mesocycle with the 3rd and 4th Tetrad had a similar procedure of the 1st mesocycle.



The red number above of the training load bar is the types of training practiced during the day of the Tetrad: 1) physical preparation (cardiopulmonary training and strength training), 2) technical training, 3) combat training with weapons and/or wooden weapons, and 4) wrestling combat training.

Figure 5. Tetrad in each mesocycle of the Roman military training with 8 months of duration (Elaborate by the author).

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Discussion

Roman military training had a very sophisticated organization because the periodization had a mesocycle of 4 to 6 months and some Tetrad in each mesocycle was the microcycle. After each mesocycle, the war coach practiced tests to determine the effect of the training. This procedure is used in the sportive periodization, most periodizations have mesocycle and microcycle, and after some mesocycles, the coach prescribes tests to determine the physiological adaptations of the athlete with evaluations of velocity, strength, and other motor capacities, and uses tests to check the athlete`s technique and tactics (Api & Arruda, 2022; Padilla, 2017).

This same procedure occurs in sportive periodization because the content was based on the periodization of the military training of ancient civilizations (China, Rome, Greece, and Egypt) and in the Tetrad created by the Greeks for the ancient sportive training (Marques Junior, 2022a). Another motive of this procedure of the sportive periodization, the sports researchers determined with research that this training structure causes high performance (Dantas et al., 2022; Matveev, 1997).

The periodization of the Roman military training had a training with divisions, how physical training, technical training, technical and tactical training, integrated training, and martial arts training. This military organization was similar in ancient China because the structure of the Chinese military training had divisions, with technical training, technical and tactical training, and martial arts training (Marques Junior, 2023a). In sportive periodization, the training also has this organization, because the training causes improvement in the athlete (Navarro, Núñez & Caraballo, 2023; Marques Junior, 2022c).

The periodization of Chinese military training had two types of periods, the military training period and the war period (Marques Junior, 2023a). But in the studies about the periodization of the Roman military training, this was not mentioned (Fernández, 2018; McAvoy, 2017; Porter, 2023; Sorrosal, 2013). However, the Roman military had two moments during military service, the first moment the military needed to always be training to be prepared for the war, or the military was fighting in the war (Parpiev, 2023; Ramalho et al., 2021). Then, the periodization of the Roman military training had two periods, the military training period and the war period, but the war coach did not use this term. Therefore, the periods of the military periodization were used according to the geopolitical event that ancient Rome was passing.

In sportive periodization, the creation of periods occurred for other reasons. Soviet sports researchers created the periods because of the seasons of Soviet Russia (1917 to 1922) and later of the Soviet Union (1922 to 1991) (Marques Junior, 2020). So, in the winter the Soviet athletes practiced during the preparatory period, and in the summer the Soviet athletes performed during the competitive period. The scientific knowledge of the Soviet sports researchers improved, so the periods were structured according to the physiological adaptations, the technical and tactical evolution, and the sportive calendar (Costa, 2022; Marques Junior, 2023b; Platonov, 2004). Another motive of the periods in the sportive periodization, this structure of the training organization guides the coach in the best way to apply the training loads (Marques Junior, 2022d).

The physical training, the technical training, and technical and tactical training of the Roman military training were exercised with more stress when the military trained in the hot, cold, and strong rain (McAvoy, 2017). This procedure is practiced in sportive training because the type of climate (hot, cold, and others) the athlete needs to train for adaptation to occur with the climate stress to have high performance (Platonov, 2004).

So, the reader learned a little about how Roman military training was organized. The review article had limitations, the author did not find how the training load was quantified in the mesocycle of 4 to 6 months and the microcycle, that was the Tetrad.

Conclusion

The sportive periodization originated from the military periodization of ancient civilizations and of the Greek Tetrad for the sportive preparation the ancient Greek athletes. Then, the study about the

periodization of the Roman military training is an important topic for sportive training researchers. The organizations of the Roman military training were very sophisticated, with several types of training (physical training, technical training, and technical and tactical training) that were structured by periodization. The periodization of the Roman military training the microcycle was the Tetrad that was inserted in the mesocycle of 4 to 6 months. But in the traditional periodization created by Matveev in the years 50, the microcycle with the training load in percentage is inserted in the mesocycle. Perhaps the Soviet sports researchers elaborated the microcycle inserted into the mesocycle based on the periodization of the Roman military training.

After each mesocycle of the Roman military training, the military practiced tests for the war coach determining the evolution of the training. This is frequently used by coaches of the current sport. Perhaps these evaluations made in the sport after the mesocycles were based on the ancient Romans. The periodization of the Roman military training had two periods, the military training period and the war period, but had limitations the periods because the Romans did not use the transition period for the military to have an active rest. An active rest was important for the Roman military because the military service was very intense during the training, and an active rest reduced the chance of injury. In conclusion, the periodization of the Roman military training was very organized for the military to achieve a high performance in the war.

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Conflict of Interest And Funding

There is no conflict of interest.

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Research Articles

Physical fitness analysis of elementary school students: a study to design an exercise program

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A. Conception and design of the study; B. Acquisition of data; C. Analysis and interpretation of data; D. Manuscript preparation; E. Obtaining funding

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Abstract

Background and Study Aim. Physical fitness is a parameter used to assess a person's ability to perform physical activities, lead a productive life and have good health. The body's ability to overcome fatigue during sports activities is very important to maintain concentration and focus on learning. Therefore, information about the physical fitness of elementary school students is very important to know.
Material and Methods. This research method uses a quantitative approach conducted by survey then giving tests and measurements to elementary school students. The sampling technique uses total sampling, so all students in one class are sampled, totaling 25 people. This research instrument uses the 12-Minute Cooper Test. Analysis is assisted using the SPSS 26 application.
Results. Based on these results, it shows that physical fitness, especially the endurance of elementary school students, is included in the moderate interpretation with a percentage of 52%. Based on the results of research on the analysis of physical fitness, especially aerobic endurance in elementary school students, it can be concluded that students' physical fitness is still in moderate interpretation.
Conclusion. The results of this study serve as a reference for designing lessons to improve physical fitness. That way these results can be taken into consideration in developing exercise programs to improve the physical fitness of elementary school students.

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Introduction

Exercise is a physical activity that is very beneficial for maintaining and improving the quality of healthy life. Sports physical activity is considered as one of the main strategies to overcome physical weakness by targeting resistance (strength and power), aerobic endurance, balance, and flexibility (Angulo et al., 2020). Exercise has high physiological demands and risk of injury due to repetitive high-intensity movements such as jumping and running in a state of fatigue (Read et al., 2016). Exercise that is done regularly also affects the body's fitness, namely for the better (Hardinata

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et al., 2021). The more often a person does sports, it can be said that the person will have a good level of physical fitness.

Physical fitness is the physical aspect of overall fitness, which gives a person the ability to live a productive life, without causing fatigue and still be able to do other physical activities (Angoorani et al., 2021). Good aerobic endurance is also used as a parameter of human fitness. The existence of good aerobic endurance means that it can be said that humans have physical fitness (Hardinata et al., 2021). So that with good fitness endurance it will have a positive impact on daily work.

The main components of physical fitness are cardiorespiratory fitness, musculoskeletal fitness, and motor fitness. Some authors also include body composition as a component of physical fitness (F. B. Ortega & Ruiz, 2015). Previous literature suggests that cardiorespiratory and muscular fitness are negatively associated with the risk of cardiovascular disease and metabolic disorders in young people (Grøntve et al., 2013), as well as the risk of overweight or obesity (Kelishadi et al., 2007). Muscle and motor fitness both have positive effects on bone health (F. B. Ortega et al., 2008). Higher cardiorespiratory fitness is associated with better mental health (F. B. Ortega et al., 2008).

The development of physical fitness, especially in the endurance section, can be done with well-organized exercises ranging from duration, repetition and intensity to have a positive effect (Bompa & Buzzichelli, 2015). Research findings that explain that various studies to improve physical fitness have been conducted including 50 Meter sprint training (Arifin, 2019), cross country training (Heru & Apri, 2019), triangle running exercise (Hardinata et al., 2021), interval training (Bo, 2023; Bravo et al., 2008; Faude et al., 2014), training with running and plyometrics (Gómez-Molina et al., 2018), circuit weight training (Bahtra et al., 2020), aerobic exercise training (Lestari et al., 2019), fartlek training on sand (Ramdhon et al., 2020), circuit training (Iswahyudi et al., 2020).

Physical activity is known to provide many health benefits in children and adolescents (World Health Organization, 2010). However, 81% of adolescents aged 11-17 years are physically inactive globally, with significant differences in the prevalence of inadequate physical activity across gender, region and country (Guthold et al., 2020). Physical inactivity poses a serious threat to public health and well-being (Ekulen et al., 2019), and there is a need to expand policies and programs that are known to be effective at increasing physical activity levels in the population, including children and adolescents (Guthold et al., 2018). Sedentary behavior is an important consideration alongside physical activity when examining the contribution of both behaviors to the health of children and adolescents (Katzmarzyk et al., 2019). Sedentary behavior is defined as waking behavior characterized by an energy expenditure of ≤1.5 metabolic equivalents while in a sitting, reclining, or lying position (Tremblay et al., 2017). Common sedentary behaviors include smartphone/tablet use, watching TV, playing video games, computer use, driving or riding in a car, and reading/studying while sitting. Excessive sedentary time is widespread among children and adolescents worldwide, and there is emerging evidence of the negative health impacts and potential public health burden associated with high levels of sedentary behavior (LeBlanc et al., 2017).

Physical fitness plays an important role in maintaining children's growth and development processes (Timpka et al., 2014). Physical fitness" refers to good health status, i.e. the ability to perform daily activities vigorously, as well as capacities associated with a low risk of chronic disease and premature death (Ruiz et al., 2009). However, the physical fitness of school-aged children continues to decline (Malina, 2007), while some physical fitness indicators have declined by as much as 50% over the past 2 decades (41), predicting an earlier onset of health problems, lowering the quality of life of the population and creating a financial burden for society. Based on a meta-analysis, Ruiz et al., (2016) suggested that cardiorespiratory fitness assessment in schools, sports clubs, or clinical settings is necessary for primary prevention of cardiovascular disease. Continuous physical fitness monitoring is recommended by the American Heart Association (AHA).

This research is important to monitor and know the extent of physical fitness possessed by elementary school students. This will be useful for teachers in designing learning activities that are appropriate to their level of fitness. Monitoring physical fitness at a national level and making this

data available to the scientific community is important and recommended (Kaminsky et al., 2013). In Lithuania, a secular trend in physical fitness at the population level has been observed over the past 2 decades for children aged 11-18 years old (Venckunas et al., 2017). However, there appears to be a lack of epidemiologic studies on the physical fitness of primary school children. Assessing and monitoring physical fitness from an early age is essential for those who want to develop young people's physical abilities for future health benefits.

The purpose of this study is to provide information to practitioners and sports teachers about the level of physical fitness possessed by students. The impact of this study for teachers is to be a reference in designing lessons in physical education, sports and health lessons appropriately according to the stage of growth, development and fitness, to be further improved. Assessment of physical fitness in children provides important information from a clinical and public health perspective that can be used to maintain and improve children's health (F. B. Ortega et al., 2014). Therefore, it is imperative for schools to implement field-based physical fitness tests that are age-appropriate for the subjects and reflect the relationship between physical fitness and health (Kolimechkov, 2017).

Materials and Methods

Participants.

The population in this study were fifth grade students of public elementary school 4 tebas, sambas district. The sampling technique uses total sampling so that all fifth grade students totaling 25 people are sampled. This research took place in January 2024 at State Elementary School 4 Tebas Sambas Regency, West Kalimantan Province.

Research Design.

This study uses a quantitative approach through the survey method. Where in this research tests and measurements are given to students to measure physical fitness. The instrument used in this study was the 12-minute Cooper Test. They then performed the 12-minute Cooper test (endurance) to measure cardiorespiratory fitness (Fjørtoft et al., 2011).

Statistical analysis.

Data analysis in this research uses descriptive percentages. Then the data calculations are assisted using the SPSS 26 application.

Table 1. 12-minute Cooper test scoring norms

Age	Excellent	Above Average	Average	Below Average	Poor
Male 13-14	>2700m	2400-2700m	2200-2399m	2100-2199m	<2100m
Females 13-14	>2000m	1900-2000m	1600-1899m	1500-1599m	<1500m

Results

The measurement test used is the 12-minute Cooper Test. Based on the results of the tests and measurements carried out, the students' physical fitness values can be seen in table 2 and figure 1. Based on the results contained in table 3 which shows that the physical fitness of elementary school students on average goes into moderate interpretation with a distance of 2211 meters.

Table 2. Distribution of Physical Fitness Values (Endurance)

Test	N	%	Interpretation
Cooper test	0	0%	Very good
	0	0%	Good
	13	52%	Medium
	12	48%	Less

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0	0%	Not at all

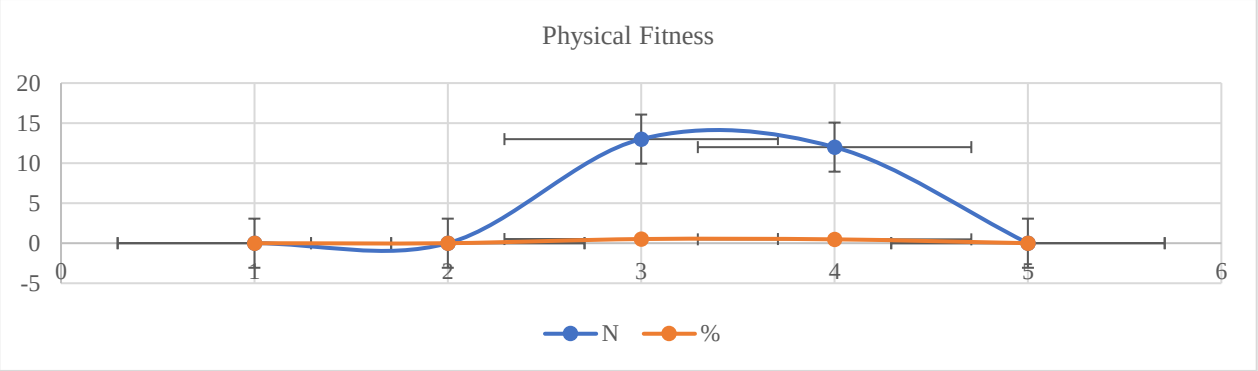

Figure 1. Physical Fitness Category

Table 3. Descriptive Statistics Data

Cooper test	N	Min	Max	Mean	Std error	Std. Deviation
	25	2100.00	2320.00	2211.4000	16.46086	82.30431

Discussion

The results of this study provide information about physical fitness, especially the endurance part of elementary school students. Based on the results of data analysis obtained, it is found that the average level of physical fitness of students is included in the interpretation of moderate with a percentage of 52% as many as 13 students and less with a percentage of 48% as many as 12 students. Overall the results of this study indicate that physical fitness, especially endurance, of elementary school students still needs to be improved. The results of this study serve as a reference for designing lessons to improve students' physical fitness, including through physical activity (Zaqout et al., 2016), and traditional games (Lobstein et al., 2015). In children and adolescents, lack of physical activity can lead to a decrease in physical fitness (Woll et al., 2013), and can increase the prevalence of overweight and obesity in both developed and developing countries (Ng et al., 2014).

The following research is an exercise program used for endurance, one of which is Ozmen & Aydogmus, (2016) found that a six-week core strength training program significantly improved balance and core endurance. However, a limitation of their study was that only adolescent badminton players were recruited. In addition, in the study, physiotherapy was essential to the intervention training program, which may be relatively difficult to incorporate into physical education classes. Oliver et al. implemented a core stability program within the elementary physical education curriculum for a period of 10 months and found that the intervention improved core strength and endurance (Oliver et al., 2010). However, a limitation of their study was that a long training period was required to produce such effects. In addition, Allen et al. integrated a six-week core stability program into the physical education classes of school children (average age 11 years), which was effective in improving trunk and core muscular endurance (Allen et al., 2014). However, a limitation of their study was the absence of a control group that could ascertain the true benefits of the intervention program. Also, how this core training program affected other parameters, such as movement ability, flexibility and balance, remains unclear.

The cardiorespiratory component of physical fitness is an important indicator of health as a systematic review reported strong evidence that higher levels of cardiorespiratory fitness in childhood and adolescence are associated with better cardiovascular health later in life (Ruiz et al., 2009). Previous literature (Ruiz et al., 2009), suggests that physical fitness in childhood is a predictor of cardiovascular disease risk, events and syndromes, quality of life, and low back pain in later life. Percentile values may be useful in identifying children who are at higher risk of developing poor health due to their low fitness levels. The authors suggest Ruiz et al., (2011) that physical fitness

levels at or below the 25th percentile should be identified as "warning signs". These children may require special attention for their further maturation and physical development.

Physical fitness is used as an umbrella term for several skill- and health-related competencies, for example, endurance, strength, speed, or coordination and can be considered a multi-faceted construct (Utesch et al., 2018). Provided evidence that it is possible to assess physical fitness using several separate subtests (e.g., specifically for endurance, strength, or coordination) and combine the results from those subtests into a surrogate for physical fitness. High physical fitness at a young age is associated with a reduced risk of overweight or obesity in adolescence (F. Ortega et al., 2011), and low physical fitness in children and adolescents is associated with adiposity, lower cardiometabolic health, and lower bone health later in life (García-Hermoso et al., 2019). Therefore, identifying factors associated with children and adolescents' physical fitness appears to be crucial for developing effective intervention strategies against low physical fitness.

Physical fitness is partly genetically determined, but can also be influenced by environmental factors (F. B. Ortega et al., 2008). Among several environmental factors, there seems to be some evidence that the socioeconomic status of parents affects the physical fitness of their children (Lämmle et al., 2012). Socioeconomic status consists of factors such as parental education, occupation, household income, rural-urban differences, and migration background (Lovecchio et al., 2018). In a cross-sectional study by Haro et al., (2019) of more than 2,600 preschool children in Spain, higher parental education levels were associated with lower levels of overweight and higher musculoskeletal fitness of their children. Results from a cross-sectional study by Lämmle et al., (2012) on approximately 2600 German children and adolescents revealed that children with a migration background and with lower socio-economic status were less active, which resulted in lower levels of physical fitness. In another cross-sectional study by Klein et al., (2016) on a cohort of approximately 1400 German children and adolescents aged 7 to 16 years, higher socioeconomic status was associated with higher physical fitness.

Previous research has reported positive associations in parent and child physical activity (Bringolf-Isler et al., 2018). Furthermore, Zaqout et al., (2016) explored the determinants of physical fitness in European children aged 6-11 years, finding that children's physical activity was an independent and strong determinant of their physical fitness. Therefore, we expected an influence of parental physical activity on children's physical fitness (Bringolf-Isler et al., 2018), compared objectively measured physical activity of Swiss parents and their children aged 6-16 years. They found that a 1-minute increase in maternal and paternal MVPA was associated with 0.24 and 0.21 minutes more MVPA in children (Bringolf-Isler et al., 2018), argue that the relationship between parent and child physical activity is strongest in children aged 10-12 years. Therefore, differences in physical fitness in children whose parents have different education may occur after the age of 10 years.

The same trend was found in the Identification and prevention of Dietary and lifestyle-induced health EFfects In Children and infants (IDEFICS) study of physical fitness reference standards in European children, which indicated that older children performed better than younger children in speed, lower and upper limb strength, but not in cardiorespiratory fitness in boys (Miguel-Etayo et al., 2014). Strong evidence suggests that higher levels of cardiorespiratory fitness in childhood and adolescence are associated with a healthier cardiovascular profile later in life (Ruiz et al., 2009).

The observed sex differences may also be explained by higher levels of physical activity by boys than by girls (Trost et al., 2002). However, between-sex differences in motor fitness are less consistently age-related. Not many comparisons can be made regarding cardiorespiratory fitness between Lithuanian children and children from other countries as these studies used different tests. Although a comparison of the results of the 9-minute running test from a survey in Germany and the 6-minute running test in the current study showed that the calculated average speed per minute was higher among 9- and 10-year-old boys from Germany than boys of the same age from Lithuania (163

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m-min-1 and 174 m-min-1 vs 152 m-min-1 and 164 m-min-1, respectively for 9- and 10-year-old boys from (Kathleen Golle et al., 2005).

Conclusion

Based on the results of physical fitness analysis research, especially aerobic endurance of elementary school students, it can be concluded that students' physical fitness is still in moderate interpretation. The results of this study provide information to practitioners and sports teachers that will be used as a reference for designing physical education learning sports and health in accordance with growth, development and fitness levels that must be improved. Overall, the conclusion will emphasize the importance of prioritizing physical fitness in primary schools and provide actionable recommendations for designing effective exercise programs to support student health and well-being. Recommendations for future research are to investigate the differences in physical fitness between primary school children of different age groups as well as the shift in physical fitness from primary to secondary school.

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Conflict of Interest And Funding

There is no conflict of interest.

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Research Articles

Proprioceptive neuromuscular facilitation (PNF) stretching in futsal sport: How does it affect recovery pulse rate after high intensity interval training?

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A. Conception and design of the study; B. Acquisition of data; C. Analysis and interpretation of data; D. Manuscript preparation; E. Obtaining funding

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Abstract

Background and Study Aim. During exercise, the work of the heart will be controlled by sympathetic nerves that will regulate the frequency of heart rate through the depolarization effect. Faster changes in depolarization effects can affect action potentials that become more frequent, so that the heart rate will increase. Stretching serves to improve blood flow and circulation, so it can help in lowering the pulse rate. This study aims to determine the effectiveness of PNF stretching on pulse rate recovery after doing HIIT on futsal players.

Material and Methods. This research is an experimental research with the design of this research is control group pretest-posttest consisting of 20 people with sampling technique using population sampling. They were divided by ordinal pairing into two groups, namely the PNF stretching group and the control group. The PNF stretching group underwent PNF stretching session after HIIT session, while the control group only did HIIT session without PNF stretching. Recovery pulse rate was measured before and after the HIIT session, as well as after the PNF stretching intervention or rest period for the control group. Analysis was assisted using SPSS 26.

Results. The results showed a significant decrease in recovery pulse rate in the experimental group with an average pretest value of 75.6, posttest 86.8 (p=0.000) with an effectiveness value of 85.8%. The control group showed a less significant decrease in recovery pulse rate, with an average pretest value of 75.2, posttest 76.8 (p=0.104) with an effectiveness value of 75.8%.

Conclusion. So that this research is expected to serve as material for consideration, reference, and knowledge for parties related to the world of sports and health science, especially the effectiveness of Proprioceptive Neuromuscular Facilitation (PNF) stretching on pulse recovery after doing High Intensity Interval Training (HIIT).

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Introduction

Futsal is a group sport consisting of 5 against 5 and is played indoors. Futsal sports are favored by all groups, because this sport is played on a closed field (Hidayat et al., 2021; Suryamen, 2016). Futsal players must be able to maintain their physical condition for 2×20 minutes in order to stay in good shape (Ashfahani, 2020; Muzaki et al., 2020). In the game of futsal aerobic and anaerobic endurance is very important to support athletes doing physical activity for a long time (Boullosa et al., 2013). Thus, a futsal player must have good physical fitness to support the game during the match to keep performing optimally. Therefore, to maintain aerobic and anaerobic endurance, futsal players must practice consistently.

There are several types of training to support the performance of futsal players, one of which is high-intensity interval training High Intensity Interval Training (HIIT). High intensity interval training is a form of cardiovascular exercise with high intensity in a relatively short time, then followed by a short period of both active and passive recovery (Ramos et al., 2015). Based on the results of research conducted (Wiewelhove et al., 2015). High intensity interval training can cause peripheral fatigue, such as muscle damage, sarcomere length redistribution, metabolic disorders, and can significantly increase muscle soreness and pulse rate.

Pulse rate can be used as an indication of a person's cardiovascular fitness. When a person experiences fatigue, the pulse rate tends to increase. This is due to the higher need of muscles for oxygen and nutrients to meet the increased energy needs in the body (Gunawan et al., 2023). Fatigue that occurs after training or competition can be prevented by cooling down or recovering (Parwata, 2015). Some futsal players often ignore the importance of restoring body condition after training by performing effective cooling, such as stretching and passive recovery.

Recovery is a recovery process that aims to restore the body's condition during post-training. (Koesherawati et al., 2022). Active and passive recovery can restore energy, pulse rate, and lactic acid levels after maximum exercise (Muhajirin L, 2016). There are several recovery techniques, namely passive recovery, active recovery, cryotherapy (cold therapy), thermotherapy (heat therapy), contrast therapy, massage, pharmacology, and nutrition. Active recovery can be done by stretching which functions to improve blood flow and circulation, increase joint motion space, reduce stiffness or pain, and as a recovery of muscle function after exercise (Rey et al., 2012).

Stretching is divided into several types, one of which is the PNF (Proprioceptive Neuromuscular Facilitation) stretching technique. PNF techniques have advantages over other types such as being able to increase muscle strength and endurance, joint stability and mobility, control and coordination to support athletes' abilities and achievements (Victoria et al., 2013). Based on the main problem above, the researcher wants to conduct an experimental study or experiment to determine the effectiveness of PNF stretching on pulse recovery after performing High Intensity Interval Training on futsal players. This research is an experimental study with the design of this research form is a control group pretest-posttest which is divided into two groups, namely the group given treatment with PNF Stretching and the group is not given cooling treatment with PNF Stretching.

Although research has previously been conducted with the title of the study, namely with the title of the effectiveness of PNF stretching on the recovery pulse after doing HIIT on futsal players. However, there are differences in the sub-variables used. Therefore, this is one of the distinctions and the importance of this research. So this study aims to determine the effectiveness of PNF stretching on pulse recovery after doing HIIT in futsal players.

Materials and Methods

Participants.

This research was conducted around GOR Yogyakarta State University and aimed at futsal players of the Sport Science Study Program, Faculty of Sport and Health Sciences, Yogyakarta State University in March 2023. The sample technique used in this study was population sampling. The samples taken in this study were futsal players of the Sports Science Study Program, Faculty of Sports

and Health Sciences, Yogyakarta State University who were male from the 2020-2021 batch totaling 20 people

Research Design.

This research is an experimental study with the design of this research form is a control group pretest-posttest which is divided into two groups, namely the group given treatment with PNF Stretching and the group not given cooling treatment with PNF Stretching. Data collection procedures in this study are divided into 3 namely pretest (initial test), intervention (treatment), and posttest (final test). The procedure for implementing the pretest and posttest is the same, namely: (1) Pretest (initial test), namely measuring the recovery pulse with a palpation technique technique, namely by sticking a finger on the radial pulse for 15 seconds and then multiplying by 4. Research subjects were given training in the form of High Intensity Interval Training (HIIT): Sprinting and jogging for 15 minutes. (3). The research subjects were given intervention (treatment) in the form of stretching techniques with the Proprioceptive Neuromuscular Fascilitation (PNF) stretching method. (4). Posttest (final test), namely measuring the recovery pulse with a palpation technique technique, namely by sticking a finger on the radial artery for 15 seconds and then multiplying by 4.

The instrument used in this study was a stop watch. Stop watch is used to calculate the time to measure the pulse rate. The data to be collected in this study is pretest data obtained from the results of the recovery pulse before the sample is given treatment, while the posttest data will be obtained from the results of the recovery pulse after the sample is given treatment with PNF Stretching method and without PNF Stretching method.

Statistical analysis.

The presentation of descriptive statistics is often done in the form of tables and diagrams. In the context of this study, descriptive analysis was used to describe variables such as age, weight, and height. Furthermore, the normality prerequisite test is carried out, to determine whether the data is normally distributed or not, the p-value is used. If the p-value is greater than 0.05, then the data is said to be normally distributed. Conversely, if the p value is less than 0.05, the data is said to be not normally distributed. Because the number of samples in this study was less than 50 people, the normality test used was the Shapiro-Wilk test. The normality test affects the next calculation process. Paired Sample t Test is used for parametric calculations, while Wilcoxon Signed Rank Test is used for non-parametric calculations. The analysis in this study was assisted using the SPSS version 26 application

Results

Based on the data analysis that has been carried out by researchers, the research results can be presented as follows:

Pretest data is obtained from the calculation of the recovery pulse rate before the subject does the exercise and before the subject does the cool down. The data shows the pulse frequency of male futsal players of the Sport Science Study Program, Department of Sport Science, Yogyakarta State University before the subject does the exercise and before the subject does the cool down. The results can be seen in table 1.

Posttest data is obtained from the calculation of the recovery pulse rate after the subject has cooled down. The data shows the pulse frequency of male futsal players of the Sports Science Study Program, Department of Sports Science, Yogyakarta State University after the subjects are cooled down. The results can be seen in table 2.

The results in table 3 show pretest data obtained from the calculation of the recovery pulse rate before the subject does the exercise and before the subject does the cooling with Proprioceptive Neuoromuscular Facilitation (PNF) Stretching. Posttest data was obtained from the calculation of the recovery pulse rate after the subject cooled down with Proprioceptive Neuromuscular Facilitation (PNF) Stretching. After the data is tested, then proceed with hypothesis testing using paired t-test

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analysis to determine the effect of Proprioceptive Neuromuscular Facilitation (PNF) stretching on pulse recovery after performing High Intensity Interval Training (HIIT) on futsal players. The results can be seen in table 4.

Table 1. Frequency Distribution of Pretest Data of Recovery Pulse Rate of Control Group

No.	Interval	Frequency	
		f(n)	%
1.	82-88	2	20
2.	75-81	4	40
3.	68-74	3	30
4.	61-67	1	10
Total		**10**	**100**

Table 2. Frequency Distribution of Posttest Data of Recovery Pulse Rate of Control Group

No.	Interval	Frequency	
		f(n)	%
1.	82-88	9	90
2.	75-81	1	10
3.	68-74	0	0
4.	61-67	0	0
Total		10	100

Table 3. Frequency Distribution of Pretest Data of Recovery Pulse Rate of Experimental Group

No.	Interval	Frequency	
		f(n)	%
1.	82-88	1	10
2.	75-81	5	50
3.	68-74	3	30
4.	61-67	1	10
Total		10	100

Table 4. Frequency Distribution of Posttest Data of Recovery Pulse Rate of Experimental Group

No.	Interval	Frequency	
		f(n)	%
1.	82-88	1	10
2.	75-81	7	70
3.	68-74	2	20
4.	61-67	0	0
Total		10	100

Table 5. Summary of Paired t-test Results of Control Group Recovery Pulse Rate

Variables Tested	p (sig.)	Description
Recovery pulse	0,140	Not Significant

Table 5. Summary of Paired t-test Results of Control Group Recovery Pulse Rate

Variables Tested	p (sig.)	Description
Recovery pulse	0,000	Significant

From table 5, the p value (sig.) is 0.140. This means p> 0.05, thus Ho is accepted and Ha is rejected, it can be concluded that there is no effectiveness of cooling that does not use PNF stretching on pulse recovery after HIIT in futsal players. The p value (sig.) is 0.000. This means that p < 0.05, thus Ho is rejected and Ha is accepted; it can be concluded that there is an effectiveness of cooling using PNF stretching on the recovery pulse rate after doing HIIT on futsal players of the Sport Science Study Program, Faculty of Sport and Health Sciences, Yogyakarta State University. The results

showed there was a significant decrease in recovery pulse rate in the experimental group with an average pretest value of 75.6, posttest 86.8 (p=0.000) with an effectiveness value of 85.8%. (2) The control group showed a less significant decrease in recovery pulse rate, with an average pretest value of 75.2, posttest 76.8 (p=0.104) with an effectiveness value of 75.8%. Results are shown in table 6

Discussion

This study aims to determine the effectiveness of PNF stretching on recovery pulse rate after doing HIIT in futsal players Vidiari et al., (2017) explained that HIIT is an exercise with high intensity in each period and with speed or load in a short time. Where this uses training with a combination of high intensity and low intensity with the aim of training cardiorespiratory which is useful for short duration repetitive attacks (Herlan & Komarudin, 2020).

The problem that often occurs is that players sometimes forget to cool down after doing maximum physical activity. There are several types of exercises performed by futsal players, one of which is high-intensity interval training (Chow & Etnier, 2017; Luthfiyandhi, 2016). HIIT is a form of cardiovascular exercise with high intensity in a relatively short time, then followed by a short period of both active and passive recovery (Nugraha & Berawi, 2017). High intensity interval training is one of the exercises that can improve endurance, strength, and physical fitness. HIIT training combines aerobic and anaerobic energy systems that require great power, therefore this exercise can cause heart rate to increase (Welis & Sazeli, 2013).

When doing exercise, the work of the heart will be controlled by sympathetic nerves that will regulate the frequency of heart rate through the effects on the spur tissue (Gunawan et al., 2023). One of the effects caused by sympathetic nerves in the SA node is the acceleration of depolarization so that the threshold will be easier to reach. Sympathetic nerve endings will secrete norphin which serves to reduce K + permeability. The depolarizing effect will occur when the inside of the cell becomes less negative, this is due to the reduced amount of calcium ions leaving the cell. A change to a faster threshold may result in action potentials becoming more frequent, resulting in an increase in heart rate (Hardi & Wangko, 2012).

There are several recovery techniques, namely passive recovery, active recovery, cryotherapy (cold therapy), thermotherapy (heat therapy), contrast therapy, massage, pharmacology, and nutrition. One of the recovery techniques that can be used is stretching. Stretching serves to improve blood flow and circulation, increase joint space, reduce stiffness or pain, and as a recovery of muscle function after exercise (Bompa & Buzzichelli, 2015). There are several types of stretching that can be used during the cooling down phase, one form of cooling is Proprioceptive Neuromuscular Facilitation (PNF) stretching.

Long et al., (2013) explained that stretching can have an impact on the muscle spindle. Muscle spindles are tasked with sending information to the spinal cord, then the spinal cord will channel the signal to the motor nerve Ylien, (2008) explains that stretching with the help of others is called Proprioceptive Neuromuscular Facilitation (PNF) stretching. PNF stretching can reduce the recovery pulse rate due to several physiological mechanisms that occur during this technique. A study by Diana Victoria et al., (2013) explained that there are several mechanisms of PNF stretching can reduce the recovery pulse.

Conclusion

The results of this study showed that there was a significant decrease in recovery pulse rate in the experimental group. Furthermore, the results in the control group showed a less significant decrease in the recovery pulse rate. Based on the results of the research and discussion described above, the authors conclude that there is an effectiveness of the application of Proprioceptive Neuromuscular Facilitation (PNF) stretching on the recovery pulse rate after performing High Intensity Interval Training (HIIT) on futsal players. This study has added a new reference related to PNF stretching, which can be applied by coaches or sports practitioners for pulse recovery after high

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intensity interval training. That way it can control more deeply about the factors that can affect the pulse rate results, so that it can be known more deeply about the results of the recovery pulse rate. Further recommendations can add other variables that can affect the results of the study.

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Research Articles

How ladder drill V-pattern and snake jump exercises impact the agility of basketball players

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A. Conception and design of the study; B. Acquisition of data; C. Analysis and interpretation of data; D. Manuscript preparation; E. Obtaining funding

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Abstract

Background and Study Aim. Agility holds a pivotal role in basketball, influencing both defensive prowess and offensive maneuvers. This research delves into the impact of V-pattern ladder drill and snake jump exercises on basketball players' agility.

Materials and Methods. Employing a quantitative methodology, this study adopts a Pre-Experimental design, specifically the Two Group Pretest-Post-test Design, executed across three stages. Utilizing purposive sampling, 15 male basketball athletes from Mariano Marcos State University were recruited as subjects. Data analysis, including normality and homogeneity tests, affirmed the data's appropriateness. Statistical analysis was facilitated using the SPSS 26 application.

Results. The findings unveiled a notable enhancement in biomotor agility ability ($p=0.005$) following ladder drill training. These outcomes imply that incorporating ladder training with V-pattern and snake jumping can positively impact basketball players' agility, potentially enhancing their court performance.

Conclusions. In conclusion, the statistical results underscore the effectiveness of ladder drill training with V-pattern and snake jumping in enhancing agility ability, thus advocating for its application in basketball training regimens.

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Snake Jump;
Agility;
Basketball.

Introduction

Agility is a fundamental attribute in basketball, which affects the defensive ability and offensive agility of the players (Moselhy, 2020). The ability to change direction, accelerate and decelerate quickly is critical to success on the court (Padrón-Cabo et al., 2020; Patni et al., 2018; Sekulic et al., 2019). Agility, as a multifaceted attribute, requires specific training methodologies to optimize performance (Li et al., 2020). Ladder training and jump training have gained popularity as effective training modalities to improve agility, due to their ability to challenge athletes' coordination, speed, and balance (Idris et al., 2023).

Talking about the periodization of training programs in order to support achievement according to Bompa & Buzzichelli, (2015) are physical, technical, tactical and mental. Especially in terms of physical we cannot be separated from the biomotor component. There are many biomotor components that are connected to the kecaboran can be displayed in the form of Figure 1.

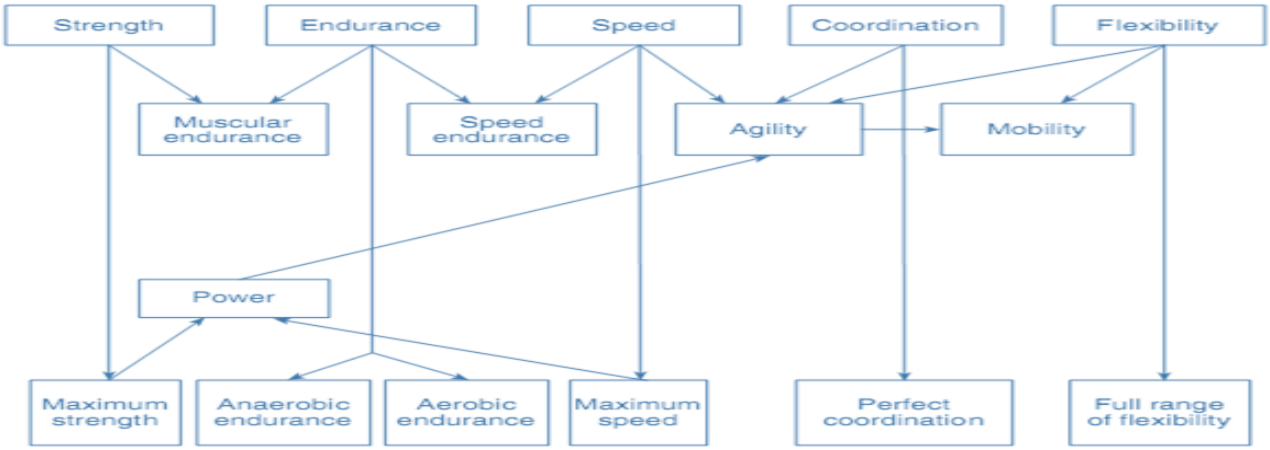

Figure 1. Biomotor Components

Recognizing the importance of agility in basketball performance, this study investigated the effects of V-pattern ladder drill training and snake jump training on the agility of basketball players. Despite the growing interest in agility training, limited research has explored the specific effects of V-pattern ladder drill and snake jump training on basketball players' agility. Understanding the efficacy of these training methods is essential for coaches and athletes who want to maximize performance potential on the field (McNeil et al., 2021; Sekulic et al., 2019; Uzun et al., 2022).

Based on these components can be developed into more specific components and higher qualifications. For example, power is the development and strength plus speed, endurance is divided into aerobic and anaerobic endurance, agility comes from speed plus balance and many others. Among the above examples, agility is one of the important elements in basketball (França et al., 2022; W. Kusnanik et al., 2019; Yasumitsu et al., 2011). Movements that combine speed and balance are required to be possessed by athletes because they match the conditions of the game pattern which is required to quickly reduce speed, stop, and accelerate back in another direction in response to external cues.

Ladder drill V-Pattern is a type of exercise using a ladder that has a diagonal movement to pass through the box and has the aim of increasing the elasticity response (Tony Reynold, 2011). This movement is done with both feet moving together to pass through the box. While the ladder drill Snake jump is intended to improve agility, balance, coordination, hip flexibility and reaction speed. This exercise starts from the foot position starting from opening from one side of the ladder, both feet jump together to turn a quarter turn and move like the direction of a snake walking. Starting from or moving down and up as shown below:

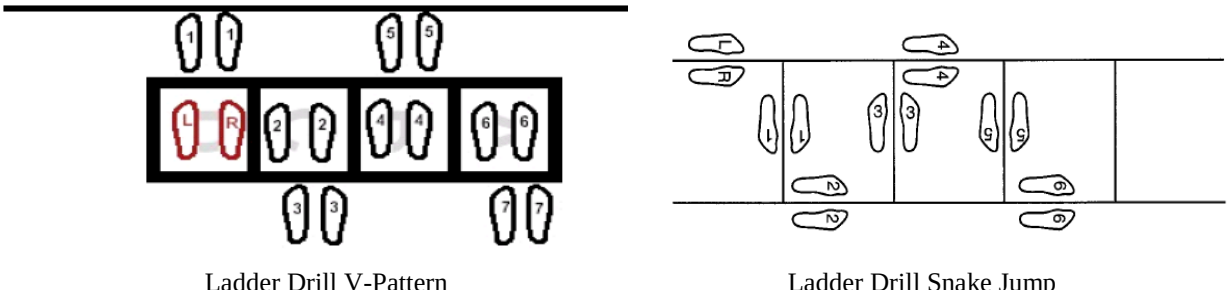

Figure 2. V-pattern ladder drill and snake jump ladder drill exercises

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Therefore, this study aims to fill this gap by examining the impact of V-pattern ladder drill and snake jump training on the agility of basketball players. This study seeks to provide empirical evidence regarding the effectiveness of these training modalities in improving the agility of basketball players. The findings from this study are expected to make a valuable contribution to the field of exercise science and inform the development of evidence-based training protocols for basketball athletes. Ultimately, the goal is to empower coaches and athletes with the knowledge and tools to optimize agility training strategies, thereby improving overall performance and competitive success in basketball.

Materials and Methods

Participants.

The subjects of this study were male basketball athletes in the environment of Mariano Marcos State University, Philippines who were preparing for the match. The sampling technique used purposive sampling so that 15 athletes were obtained with an age range of 19-23 years.

Research Design.

This type of research is quantitative research using pseudo-experimental methods because it looks for a causal relationship between two variables and cannot control controlled subjects. One of the main characteristics of experimental research is treatment. This research design uses two-group pretest-posttest because it consists of two groups (no control group) and the research process is carried out in three stages.

The data obtained comes from the initial test, namely the T-test, before giving the program and the final test after the program is completed. Dosage determination of the program based on the athlete's ability starting from the physiological adaptation phase (Bompa, O, Tudor & Buzzichelli, 2019). The following exercise program can be seen in tables 1 and 2.

Table 1. Ladder Drill V-Pattern Training Program

Day/Date		Exercise Type	Set	Rep	Rest
Week 1	Wednesday	Pre Test T-Test			
	Saturday	Exercise Adaptation			
	Sunday	Exercise Adaptation			
Week 2	Wednesday	V-Pattern	4	60%	1 minute
	Saturday	V-Pattern	4	60%	1 minute
	Sunday	V-Pattern	4	60%	1 minute
Week 3	Wednesday	V-Pattern	4	60%	1 minute
	Saturday	V-Pattern	4	60%	1 minute
	Sunday	V-Pattern	4	60%	1 minute
Week 4	Wednesday	V-Pattern	4	70%	1 minute
	Saturday	V-Pattern	4	70%	1 minute
	Sunday	V-Pattern	4	70%	1 minute
Week 5	Wednesday	V-Pattern	4	70%	1 minute
	Saturday	V-Pattern	4	70%	1 minute
	Sunday	V-Pattern	4	70%	1 minute
Week 6	Wednesday	V-Pattern	4	80%	1 minute
	Saturday	V-Pattern	4	80%	1 minute
	Sunday	V-Pattern	4	80%	1 minute
Week 7	Wednesday	V-Pattern	4	80%	1 minute
	Saturday	V-Pattern	4	80%	1 minute
	Sunday	V-Pattern	4	80%	1 minute
Week 8	Wednesday	Post Test T-Test			
	Saturday				
	Sunday				

Table 2. Ladder Drill Snake Jump Training Program

Day/Date		Exercise Type	Set	Rep	Rest
Week 1	Wednesday	Pre Test T-Test			
	Saturday	Exercise Adaptation			
	Sunday	Exercise Adaptation			
Week 2	Wednesday	snake jump	4	60%	1 minute
	Saturday	snake jump	4	60%	1 minute
	Sunday	snake jump	4	60%	1 minute
Week 3	Wednesday	snake jump	4	60%	1 minute
	Saturday	snake jump	4	60%	1 minute
	Sunday	snake jump	4	60%	1 minute
Week 4	Wednesday	snake jump	4	70%	1 minute
	Saturday	snake jump	4	70%	1 minute
	Sunday	snake jump	4	70%	1 minute
Week 5	Wednesday	snake jump	4	70%	1 minute
	Saturday	snake jump	4	70%	1 minute
	Sunday	snake jump	4	70%	1 minute
Week 6	Wednesday	snake jump	4	80%	1 minute
	Saturday	snake jump	4	80%	1 minute
	Sunday	snake jump	4	80%	1 minute
Week 7	Wednesday	snake jump	4	80%	1 minute
	Saturday	snake jump	4	80%	1 minute
	Sunday	snake jump	4	80%	1 minute
Week 8	Wednesday	Post Test T-Test			
	Saturday				
	Sunday				

Statistical analysis.

Data analysis in this study through the normality prerequisite test, if the data is normal, it will be continued with the t test and if it is not normal, it will be tested with non-parametric assisted using the SPSS Version 26 application.

Results

The results of the data description research are presented by recording the testing of samples who perform detailed exercises can be seen in the table as follows. Based on table 3 shows the average value of speed ability in pretest basketball athletes 20.68 while in the post test 19.72 after variation training.

Table 3. Pretest and Posttest Results

Assessment	N	Min.	Max.	Mean	Std. Deviation
Basketball Agility Pretest	20	18.06	24.35	20.6830	2.20479
Bolabasket Agility Post test	20	17.38	22.46	19.7230	1.85602

Based on the results of the normality test, it is known that the significance value (p = 0.200> 0.05), it can be concluded that the residual value is normally distributed. Based on the homogeneity test results, it is known that the significance value is 0.395> 0.05, it can be concluded that the value is homogeneous. The results can be seen in tables 4 and 5.

It is known that the calculated significance value of 0.000 <0.05 which means smaller, so there is a significant effect of ladder drill v-pattern training and ladder drill snake jump on increasing agility in basketball games. The results can be seen in table 6.

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Table 4. One-Sample Kolmogorov-Smirnov Normality Test

Asymp. Sig. (2-tailed)	Distribution	Exercise
.200[c,d]	Normal	ladder drill v-pattern
.200[c,d]	Normal	ladder drill v-pattern

Table 5. Homogeneity Test

Test of Homogeneity of Variances		Levene Statistic	df2	Sig.
Basketball Agility	Based on Mean	.739	38	.395

Table 6. Paired Sample t Test

No.	Assessment	mean	t	df	Sig.(2- tailed)
Pair 1	Ladder Drill V-Pattern	.96000	5.233	14	0.000
Pair 2	Ladder Drill Snake Jump	.98000	5.143	14	0.000

Discussion

This study aims to determine the effect of ladder drill v-pattern and ladder drill snake jump on agility in basketball games. The results showed that there was a significant increase in agility in basketball games. The findings of this study provide valuable insight into the effectiveness of V-pattern ladder drill and snake jump training in improving the agility of basketball athletes. Agility is an important attribute in basketball, which affects a player's defensive ability and offensive maneuvers (Pradana et al., 2020). Therefore, understanding the impact of certain training modalities on agility is essential to optimize performance on the field.

The results showed a significant improvement in biomotor agility ability among basketball athletes after the application of V-pattern ladder drill and snake jump training. These findings are consistent with previous research highlighting the efficacy of agility-focused training regimens in improving athletic performance across a range of sporting disciplines (Hananto Puriana et al., 2023).

Ladder drills are widely recognized for their ability to improve footwork, coordination and agility. Variations of the V pattern add complexity by incorporating diagonal movements, further challenging the athlete's ability to change direction quickly and maintain balance. Similarly, snake jumping drills require athletes to perform explosive movements while maintaining stability, thereby improving agility and dynamic balance (Anwar et al., 2020; El-Hadi Sabbah, 2017).

The significant improvement observed in biomotor agility ability underscores the effectiveness of V-pattern ladder drill and snake jump training as targeted training modalities for basketball athletes (Hananto Puriana et al., 2023). By systematically incorporating these drills into training routines, coaches can help athletes develop the agility necessary to excel in defensive maneuvers, such as lateral movement and quick changes of direction, as well as offensive strategies, including driving to the basket and evading defenders (Okilanda et al., 2021; Rozi et al., 2023).

In addition, the findings from this study have practical implications for basketball coaches and trainers. By integrating V-pattern ladder drill and snake jump drills into training programs, coaches can address specific deficiencies in athletes' agility and provide specific interventions to improve performance. In addition, incorporating variety and progression into agility training routines can help prevent boredom and optimize skill development over time (Hananto Puriana et al., 2023).

Furthermore, although this study focused on biomotor agility ability as the primary outcome measure, future research could explore additional performance indicators, such as defense effectiveness, attack efficiency, and injury prevention. Longitudinal studies that track athletes' progress over a long period of time may also provide valuable insights into the sustained effects of agility training interventions.

Conclusion

In conclusion, the findings from this study contribute to the knowledge of agility training in basketball and support the efficacy of V-pattern ladder drill and snake jump drills in improving athletes' agility. By incorporating these exercises into training programs, coaches can help basketball athletes develop the multidimensional agility necessary for success on the court. However, it is important to recognize some of the limitations of this study. The sample size was relatively small, consisting of 15 male basketball athletes from one university, which may limit the generalizability of the findings to a wider population. Future research could benefit from a larger sample size and include female athletes to provide a more comprehensive understanding of the effects of V-pattern ladder drill and snake jump drills on agility across different demographics.

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There is no conflict of interest.

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Review Articles

Movement reinforcement factors related to children's motor skills: a review study in sports education

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Abstract

Background and Study Aim. Children's motor development is one of the important aspects in shaping children's health and quality of life. Good motor skills not only enable children to participate in various physical activities, but also play a role in their social, emotional and cognitive development. Therefore, it is important for sports educators to understand the factors that influence children's motor development. This study aims to present a comprehensive review of the factors that reinforce children's motor development in the context of sport education.

Material and Methods. This study used a literature review design following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The data used in this study were published articles published in national and international journals. The search for publication articles was carried out using several journal database websites such as ScienceDirect and Google Scholar. Through the literature review, these articles identified key factors related to improving children's motor skills. After the exclusion criteria, only 4 articles were categorized.

Results. These factors include physical, psychological and environmental aspects that influence children's motor development. In this study, we investigated the relationship between factors such as physical exercise, children's psychological understanding of movement, the role of teachers in providing appropriate guidance, a supportive learning environment, and external factors such as healthy diet and lifestyle. The findings from this review highlight the importance of a holistic approach in supporting children's motor development.

Conclusion. Through a better understanding of the factors that influence children's motor movements, sport educators can design more effective and sustainable programs to improve motor skills as well as overall health at important developmental stages in children's lives.

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Introduction

The changing lifestyle of children in this modern era illustrates a significant transformation in their lifestyle and daily activities (Iswanto & Widayati, 2021). In the past, children often engaged in physical activities outside the home, such as playing soccer, cycling or just playing and exploring the surrounding environment (Driller et al., 2023). However, along with technological advances, there has been a shift towards a more sedentary lifestyle. Sedentary lifestyle is an activity or lifestyle that tends to do little physical activity or movement outdoors, only focusing on doing something that feels comfortable indoors such as playing gadjet, television or games and so on (Putranto et al., 2023). This happens a lot, especially among children.

Lifestyle is the attitude, values, and behavior that a person uses in spending his time in activities and can change due to the influence of circumstances and the environment (Arham & Agustang, 2021). Lifestyle is closely related to changing times and technological developments. These lifestyle changes have triggered concerns about the decline in physical activity levels, which can have a negative impact on children's health and development. Amidst the flow of information and digital entertainment, children tend to spend more time indoors and less time engaged in physical activities. Children's motor development not only includes gross and fine physical skills, but also has a significant impact on their cognitive, social and emotional aspects. The role of teachers and coaches in supporting movement development is key to countering the sedentarization trend and ensuring that children have a strong foundation in their motor skills.

The importance of motor skills for every student to have because it has benefits and influences on the development of students as a whole. Students will have a healthy and fit body because doing movement activities improves cardiorespiratory system fitness (Cohen et al., 2015), improve the performance of the metabolic and neuromuscular systems (Laukkanen et al., 2014), causing positive changes in physiological and anthropometric indices of health of normal weight and obese students (Lambrick et al., 2016), and determinants of fitness in adolescence (Barnett et al., 2008).

Growth and development in elementary school-age children are strongly influenced by the environment around them, such as family, social environment, and school environment (Fadhullah et al., 2020; Hu et al., 2022), and also stimulates children's physical fitness and motor development (Hu et al., 2022). In addition, in the school environment the teacher becomes an important agent in providing services to improve motor skills, in order to meet the development and growth and behavioral needs of each student in the future, knowing the phases of student development is an important part so that the phases of motor skills can all be carried out and the phase is mastered according to the age level of the student (Hidayati, 2017; Iswanto & Widayati, 2021; Khaulani et al., 2020; Mustafa & Sugiharto, 2020; Nugraha, 2015). Children's gross motor movements need to be well developed so that in the future they have good hard skills (Hadi et al., 2017; S. et al., 2020).

In its application, motion reinforcement learning requires reinforcement techniques that need to be developed by a teacher or trainer. Therefore, an in-depth understanding of motion reinforcement techniques and the role of teachers/trainers in the development and learning of motion is essential in supporting future generations to have strong motor skills, optimal health and awareness of the importance of an active lifestyle in living everyday life (Reviyanti & Reza, 2023). This study aims to provide a comprehensive overview of the factors that influence children's motor skills in the context of sports education. Understanding these factors is expected to help educators, parents and policy makers in designing effective and sustainable sports education programs to improve children's motor skills.

This study uses the literature review method by collecting and analyzing relevant previous studies. Data were collected from academic journals, books and other reliable sources that discuss children's motor skills and sports education. Thus, this study is expected to make a positive contribution to the development of sports education programs that are able to improve children's motor skills effectively and efficiently.

Materials and Methods

Search Strategy.

The search in this study started using the ScienceDirect and Google Scholar databases, which are considered as one of the indexing systems for citations (Samsuddin et al., 2020). The search strategy included a combination of keyword variations ("Sports Education" AND "Children's Motor Movements" AND "Motion Reinforcement Factors"). The search was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Mohamed Shaffril et al., 2019). In addition, PRISMA emphasizes review reports that evaluate randomized trials which can also be used as a basis in reporting systematic reviews for other types of studies (Moher et al., 2009).

Exclusion Criteria.

The exclusion criteria used were as follows: (1) Articles that were not published in journals indexed in the Scimago Journal Rank (SJR), (2) Articles in languages other than English, (3) Articles that did not explicitly mention motion reinforcement factors related to children's motor skills.

Procedure.

Initially, 2,223 publications were identified through database searches (ScienceDirect: 1,110 articles) and (Google Scholar: 1,113). After following the exclusion criteria, only 4 articles remained. Most of the items were discarded because the articles did not address the motion reinforcing factors associated with children's motor skills in sports education. All articles were extracted from the source and analyzed through Mendeley software to remove duplicate articles. The PRISMA flow can be seen in figure 1.

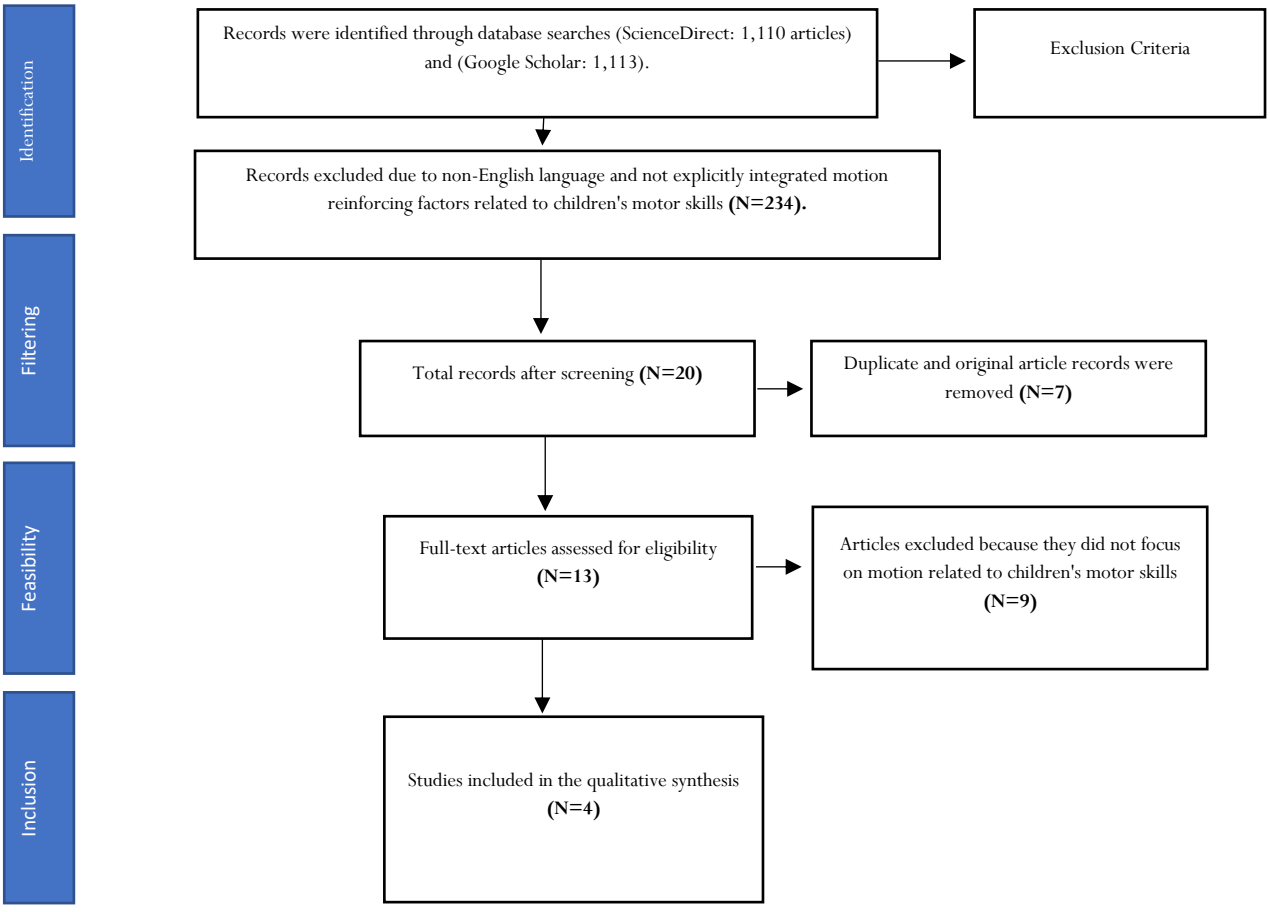

Figure 1. PRISMA Research Flow

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Results

The results of research using the Systematic Literature Review model and data extraction carried out from national and international articles, as as the main article with a variety of studies that have been conducted in various places. The literature obtained in particular is related to factors that affect motion reinforcement in learning and children's motor development as well as the role of teachers/trainers in strengthening children's motion. The results of these relevant journal articles will then be presented in the form of data tabulation. The following is a data tabulation of the results of the extracted journal articles. The research results can be seen in table 1.

Table 1. The summary of studies presenting BCAAs effect on athletic performance

Author, Year	Sample	Research Title	Research Results
(Ozbar et al., 2016)	70 Children aged 4-6 years	The effect of movement education program on motor skills of children	The aim of this study was to contribute to the improvement of basic motor skills of pre-school children between 4-6 years of age with the help of a movement education program. Another aim is to provide support to the development of activities in pre-school education programs. As a result, it was found in this study conducted to investigate the motor development of 4-6 year old children that the educational program caused significant differences in the motor development of children in the experimental group. As a result, it was determined that the educational program positively influenced the nature of children's motor development.
(Ceylan et al., 2014)	945 children aged 7-12 years.	The examining body composition, sprint and coordination characteristics of the children aged 7-12 years.	he purpose of this paper is to examine body composition, sprint parameters, and coordination in children aged 7-12 years by gender and age. To determine the body composition values of the children, the Body Mass Index was calculated. In addition, to determine sprint performance; the 30 m sprint test, for coordination skills; the eight-run test, was used. It was observed that the speed and coordination performance of girls and boys improved with age. Children's Body Mass Index increases due to the increase in body height and weight resulting from their physical evolution. The reason boys perform better than girls at all ages may be attributable to the different endocrine systems that begin with puberty. Differentiation in the endocrine system can affect body composition. It is thought that growth processes may play an important role in children's performance

(Cohen et al., 2014)	The sample in this study was 460 children	Fundamental movement skills and physical activity among children living in low-income communities: a cross-sectional study	he purpose of this study was to examine the relationship between basic movement skill competence and objectively measured moderate-to-vigorous physical activity (MVPA) throughout the school day among children attending primary schools in low-income communities. Object control skill competence appears to be a better predictor of children's MVPA during school-based physical activity opportunities compared to locomotor skill competence. Improved locomotor basic skills competence, particularly object control skills, may contribute to increased levels of children's MVPA throughout the day
(Kakebeeke et al., 2012)	Sample in the study 101 children aged 3 and 5 years old	Improvement in gross motor performance between 3 and 5 years of age1	This study examined the gross motor performance of 101 typically developing children aged between 3 and 5 years (48 boys, 53 girls, mean age = 3.9 years). statistically significant age differences were found, while for bouncing up and jumping down, none were apparent. The average motor performance did not differ between boys and girls in these tasks. The older the children, the better their performance on the tasks.

Discussion

This statement reflects the importance of the tabulated data from the journal article above, showing that the reinforcement of movement in learning and motor development is influenced by many factors, ranging from age, gender, activity level and conditions of the child's social environment.

Motion Reinforcing Factors in Children's Motor Skills

Children's motor skills are an important component of physical and cognitive development that is closely related to daily activities and performance in sports education. Motor skills include body coordination, balance, agility, strength and accuracy of movement. Sport education plays a significant role in developing these skills through a variety of physical activities that are structured and specifically designed to stimulate children's motor skills.

The first article aims of this study is to contribute to the improvement of basic motor skills of pre-school aged children between 4-6 years of age with the help of a movement education program. The other aim is to provide support to the development of activities in pre-school education programs. As a result, it was found in this study conducted to investigate the motor development of children aged 4-6 years that the educational program caused significant differences in the motor development of children in the experimental group. As a result, it was determined that the educational program positively influenced the nature of children's motor development (Ozbar et al., 2016).

Furthermore, the second article aims of this paper is to examine body composition, sprint parameters, and coordination in children aged 7-12 years by gender and age. To determine the body composition values of the children, the Body Mass Index was calculated. In addition, to determine sprint performance; 30 m sprint test, for coordination skills; eight-run test, was used. It was observed that the speed and coordination performance of girls and boys increased with age. The Body Mass Index of children increases due to the increase in body height and weight resulting from their physical evolution. The reason boys perform better than girls at all ages may be attributable to the different

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endocrine systems that begin with puberty. Differentiation in the endocrine system can affect body composition. It is thought that growth processes may play an important role in children's performance (Ceylan et al., 2014).

In the third article the aim of this study was to examine the relationship between locomotor basic skills competence and objectively measured moderate-to-vigorous physical activity (MVPA) throughout the school day among children attending primary schools in low-income communities. Object control skill competency appeared to be a better predictor of children's MVPA during school-based physical activity opportunities compared to locomotor skill competency. Improved competence in basic locomotor skills, particularly object control skills, may contribute to increased levels of children's MVPA throughout the day (Cohen et al., 2014).

Finally, the fourth article examined the gross motor performance of 101 typically developing children aged between 3 and 5 years (48 boys, 53 girls, mean age = 3.9 years). Results showed statistically significant age differences were found, while for rising and jumping down, none were apparent. Average motor performance did not differ between boys and girls in these tasks. The older the children, the better their performance on these tasks (Kakebeeke et al., 2012).

Based on this exposure, it is recognized that movement reinforcement in children's learning and motor development is influenced by a number of complex and varied factors. The following is a further explanation of the factors that may influence movement reinforcement in the context of learning and motor development including; (1) Age factors have a major impact on children's physical and motor abilities. At certain stages of development, children can be more responsive to certain movement strengthening exercises. In addition, motion reinforcement programs need to be tailored to the appropriate stage of motor development to achieve optimal results. (2) Biological differences between the sexes may affect the response to motion strengthening exercises. Some studies have shown differences in the development of strength and motor skills between boys and girls. Therefore, motion strengthening programs may need to be adjusted to take these differences into account. (3) Physical activity levels can generally affect movement strengthening. Children who regularly engage in physical activity may have a better fitness base, which may affect the response to motion strengthening exercises. Conversely, children who are less active may require a more cautious approach. (4) Environmental factors, such as family support, accessibility to sports facilities, and the physical culture around the child, can play an important role in the effectiveness of a movement strengthening program. A supportive environment can provide additional motivation and opportunities to engage children in physical activity.

Psychosocial aspects, such as children's motivation, interest and self-perception of physical activity, can also influence their participation in movement enhancement programs (Dewi & Faridah, 2022). Creating a positive environment and providing intrinsic motivation can increase the effectiveness of the program. Support from teachers, coaches, and the educational environment can contribute to the success of a movement reinforcement program (Šumar et al., 2022). Positive engagement and adequate support can motivate children to actively participate in movement strengthening activities (Harianto et al., 2023). A further benefit that can be obtained is that students can learn from their experiences by doing movement activities. When doing movement activities, children can explore their environment so that it can stimulate cognitive development and academic achievement (Fedewa & Ahn, 2011; Tandon et al., 2016), recognizing body movement, body awareness, spatial awareness, quality of movement, and the link between movement skills and limbs (Abels & Bridges, 2010).

The existence of motor skills encourages to improve psychological and mental health (Lobstein et al., 2015)motor skills are beneficial for social and emotional development (Strong et al., 2005). The magnitude of the benefits that can be obtained by students in learning motor skills should be a serious concern for parents and teachers. Students who learn movement skills not only improve their movement abilities but can also improve cognitive, affective, and socio-emotional abilities.

Conclusion

Strength training in motor learning refers to the use of exercises focused on developing muscular strength and endurance to improve motor skills. This approach aims to improve physical ability, muscle control and balance, all of which are important factors in movement learning. By understanding and considering these factors, movement strengthening programs in the context of motor learning can be more effectively designed and tailored to the individual needs of the child. A holistic and evidence-based approach will have a positive impact on children's motor development and overall health. Future researchers can add other keywords and databases such as ERIC, EBSCO (SPORTDiscus and Psy-chology & Behavioral Sciences Collection) and other databases in the article search.

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There is no conflict of interest.

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